

Southern San Jacinto Fault: recent activity

Ken Hudnut, USGS

National Earthquake
Prediction Evaluation
Council Meeting

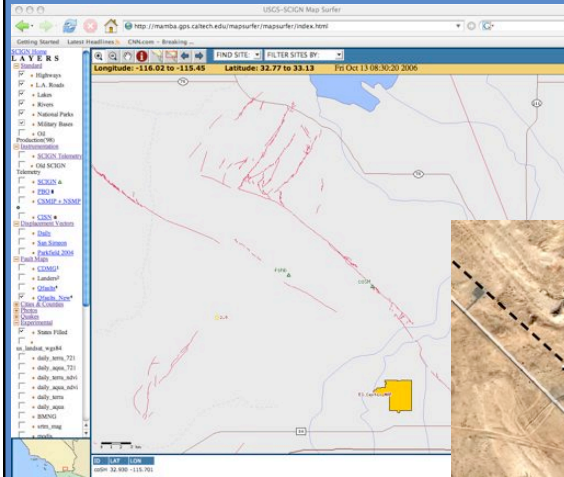
*Univ. of California, Riverside
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Acknowledgments

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- UNAVCO (PBO) and USGS (SCIGN)
- USGS NEHRP (creep)
- US Navy (base access & permits)

Superstition Hills Fault



Roger Bilham recorded a creep event sequence at his instrument near Imler Road crossing



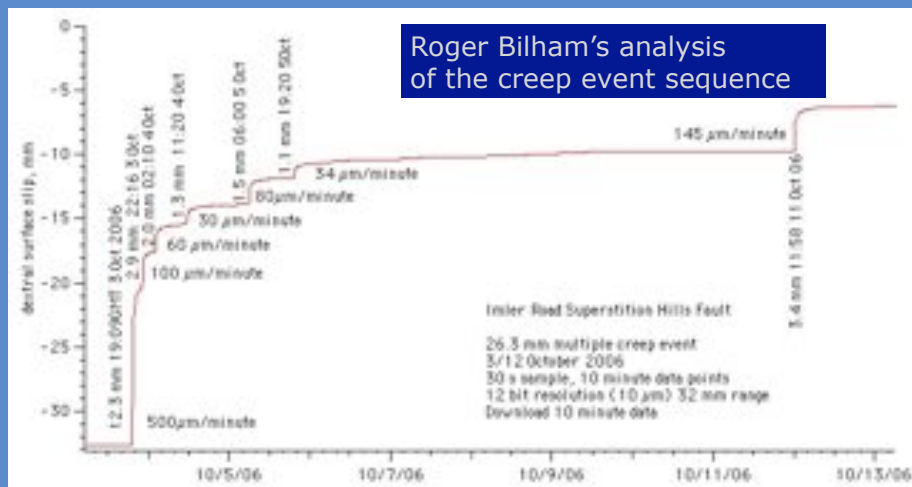
Bilham, R., Surface slip subsequent to the 24 November 1987 Superstition Hills, earthquake, California, monitored by digital creepmeters, Bull. Seism. Soc. Amer., 79(2), 425-450, 1989

Bilham, R., and J. Behr, A two-depth model for aseismic slip on the Superstition Hills fault, California, Bull. Seism. Soc. Amer., 82, 1223-1235, 1992

Bilham, R. N. Suszek and S. Pinkney, California Creepmeters, Seism. Res. Lett. 75(4), 481-492, August 2004

Superstition Hills Fault

<http://cires.colorado.edu/~bilham/CREEPDATA/SuperstitionCreep.htm>



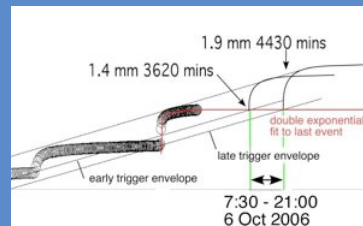


Field studies have confirmed creep along >7 km of the SHF

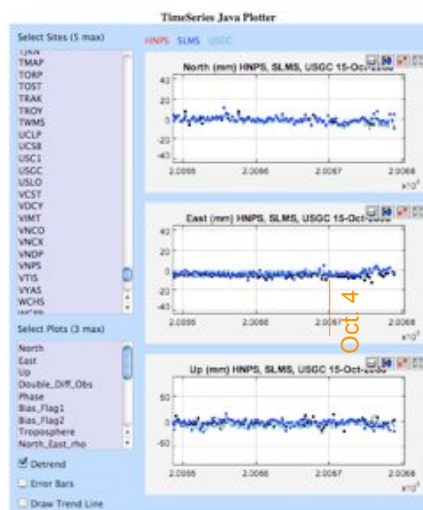
One prior large sequence of creep events described by R.V. Sharp in mid-1990's

Creep is predictable (Marano & Bilham)

"The sixth subevent is not anticipated until 10-11 Oct and this will bring slip to 25 mm."



Continuous GPS data show no transients in association



Courtesy of
Bob Dollar, USGS

Long-base laser strainmeter data show no transients in association



New PBO
strainmeters
at Salton City

Courtesy of
Frank Wyatt, UCSD

What is special
significance of
creep, if any?

from Hudnut & Clark
(BSSA, 1989)

Triggered Slip: A Valid Earthquake Precursor?

A simple test for validity of triggered slip as an earthquake precursor is to consider its documented occurrences that were referred to in the introduction. Table 1 shows that, despite apparent precursory relationships on the Imperial fault and Superstition Hills fault, triggered slip also occurs after large earthquakes, as on the Imperial fault and Coyote Creek fault. Slip events in 1987 on the Coyote Creek fault and in 1981 and 1987 on the Imperial fault differ in a notable way from the other triggered slip events. They follow major ruptures of these faults and occur early enough in the earthquake cycle so they cannot reasonably be considered precursors to the next major event.

TABLE 1
OCCURRENCES OF TRIGGERED SLIP

Event	SAF	SHF	IF	CCF
1908	yes	yes	yes	eq
1979	yes	yes	eq	maybe*
1981	no†	yes	yes	no†
1986	yes	no (?)	no (?)	no (?)
1987	yes‡	eq	yes	yes

*"Eq" indicates an earthquake. "No" is queried where absence of observations is a possible reason. SAF refers to the southern segment of the San Andreas fault; other abbreviations are: SHF, Superstition Hills fault; IF, Imperial fault; CCF, Coyote Creek fault.

† Louis *et al.* (1985) found a high creep rate over the period November 1979 through 1982. Pua (1982) mentioned unpublished alignment array data that suggested slip but we find these data were noisy (Fig. 4). No surface fractures were observed.

‡ Reported by Sharp *et al.* (1986a).

§ McGill *et al.* (1989) documented triggered slip with creepmeter data. No surface fractures with significant displacement were observed, however.

The coincidence of triggered slip in 1908 on the Imperial fault with an ensuing $M > 6$ event in 1979 led Sieh (1982) to suggest that triggered slip may be an earthquake precursor. Table 1 shows that additional empirical evidence, accumulated after the 1981, 1986, and 1987 events, does not follow Sieh's hypothesis. Triggered slip has clearly both followed and preceded $M > 6$ events. We therefore suggest a corollary to his hypothesis: if this phenomenon is to be identified as a precursor based on empirical evidence, it should also be shown that triggered slip events are occurring late in the earthquake cycle, perhaps as a surface expression of precursory slip at depth, rather than merely as afterslip of the previous event.



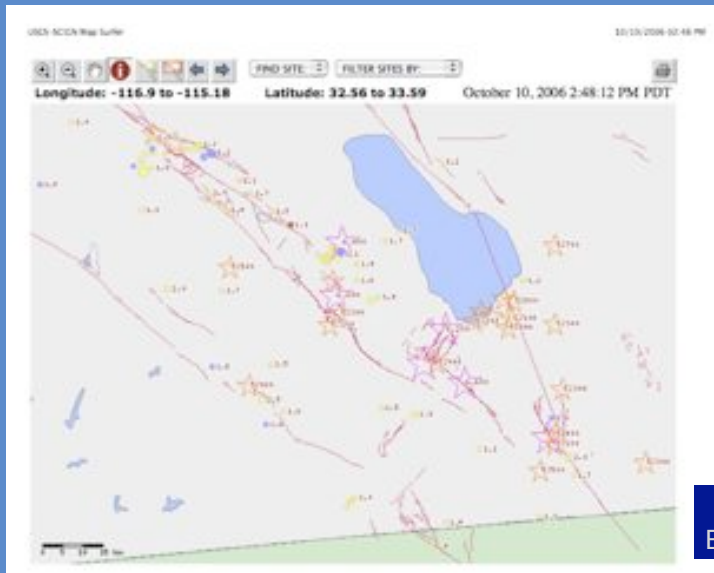
Conclusions

- Seismicity elevated but not anomalous along the So. San Jacinto and cross-faults (Extra fault and others)
- Associated generally in space and time with creep event sequence on SHF (after ~5 yr. hiatus), early Oct. '06
- No evidence from GPS or strain data that SHF creep was associated with deep-seated or regional fault motions
- Will continue to observe activity closely; very limited deployments (e.g., field mapping; 10 Hz GPS testing at Fort Scotty; new PBO site)



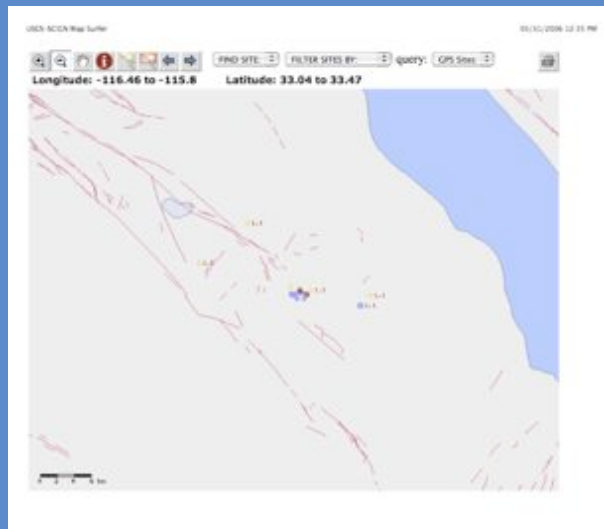
backup

Historical M 5-6's



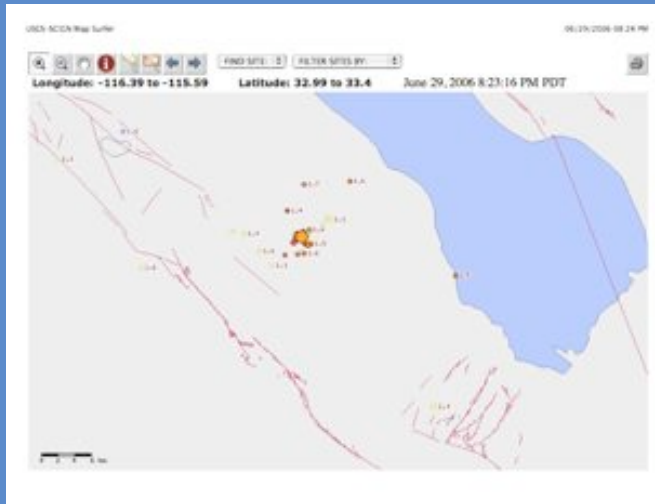
Courtesy of
Bob Dollar, USGS

May 31, 2006



Courtesy of
Bob Dollar, USGS

June 29, 2006



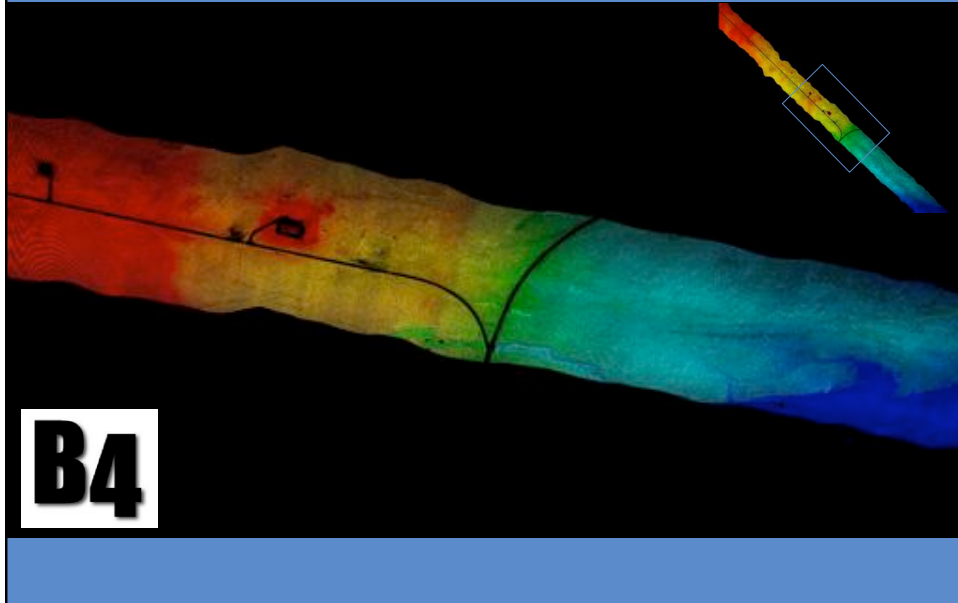
Courtesy of
Bob Dollar, USGS

So. SJF earthquakes 2006; SE end of Clark strand

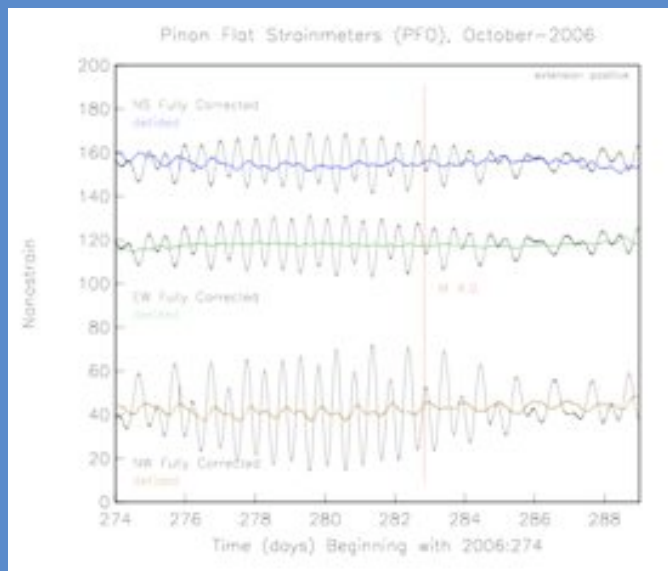
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2006/01/18 12:28:05.81 le 2.981 33.216 -116.084 13.7 A 14209232 86 960
2006/03/29 13:24:25.75 le 2.571 33.167 -116.038 12.1 A 14219436 86 698
2006/05/31 05:40:51.75 le 2.611 33.250 -116.126 6.0 C 10185829 70 872
2006/06/03 09:16:43.78 le 2.641 33.249 -116.125 11.4 A 10186533 88 886
2006/06/03 13:56:20.53 le 3.011 33.250 -116.123 8.8 B 10186597 83 1059
2006/06/03 14:24:17.36 le 2.831 33.251 -116.130 4.5 A 10186621 93 1029
2006/06/04 19:35:03.14 le 2.711 33.230 -116.041 1.9 A 10186873 71 952
2006/06/30 00:28:06.56 le 4.291 33.241 -116.036 3.6 A 14236768 108 1857
2006/06/30 00:30:00.60 le 3.20 h 33.244 -116.034 4.3 A 14236772 79 1857
2006/06/30 00:31:15.70 le 2.541 33.243 -116.028 5.7 C 14236776 48 380
2006/06/30 00:35:11.82 le 2.861 33.240 -116.028 4.4 A 14236784 101 792
2006/06/30 01:59:39.91 le 3.001 33.244 -116.037 2.6 A 14236828 88 763
2006/06/30 03:13:05.23 le 2.951 33.235 -116.040 2.7 A 14236860 81 815
2006/06/30 09:35:41.14 le 2.501 33.251 -116.033 3.5 A 14237000 55 653
2006/06/30 15:20:52.64 le 3.381 33.249 -116.028 3.7 A 14237056 86 955
2006/07/05 02:57:01.87 le 2.521 33.244 -116.029 2.9 A 14238124 74 675
2006/07/15 15:58:10.40 le 2.641 33.242 -116.041 3.5 A 14240236 59 682
2006/07/15 20:53:02.00 le 2.691 33.239 -116.036 3.4 A 14240452 77 709
2006/07/24 06:30:50.30 le 2.591 33.251 -116.124 10.9 A 14242616 80 693
2006/08/01 09:16:22.74 le 2.981 33.249 -116.128 3.1 A 14244008 114 791
2006/08/01 16:55:41.57 le 2.861 33.243 -116.039 2.1 A 14244072 54 650
2006/08/06 01:44:52.56 le 2.531 33.249 -116.129 2.9 A 10200673 71 616
2006/08/07 01:01:42.37 le 3.591 33.243 -116.036 9.2 A 10200841 130 1902
2006/09/06 22:18:01.51 le 3.621 33.176 -116.044 12.9 A 10206665 129 1889
2006/09/11 21:56:25.18 le 2.821 33.236 -116.118 10.3 A 10207421 74 674
2006/09/17 21:50:09.24 le 2.901 33.245 -116.123 11.6 A 10208489 112 713
2006/10/01 14:50:33.36 le 2.661 33.242 -116.115 4.4 A 14254196 60 748
2006/10/01 20:06:42.17 le 2.751 33.247 -116.121 3.8 A 14254252 66 713
2006/10/09 20:26:50.88 le 3.921 33.261 -116.072 8.5 A 14255632 162 1927

Number of events: 29

B4 data for this section of SHF

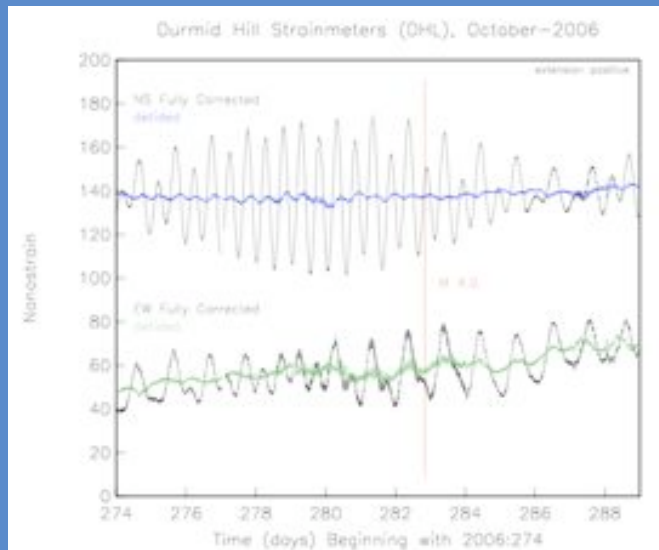


Long-base laser strainmeter data: PFO



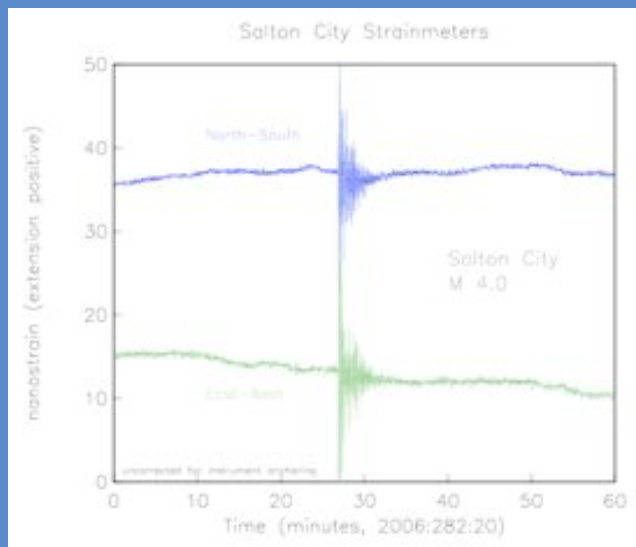
Courtesy of
Frank Wyatt, UCSD

Long-base laser strainmeter data: Durmid Hill



Courtesy of
Frank Wyatt, UCSD

Long-base laser strainmeter data: Salton City M 4.0



Courtesy of
Frank Wyatt, UCSD